FORTNIGHTLY'S

SPARK

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Nuclear power, like love, is what the world needs now. But as with love itself, "need" and "want" don't always see eye-to-eye. So our energy policy falls short, with nuclear joining love – as yet one more thing there's just too little of.

None of this, however, seems to discourage Mary Anne Sullivan, Daniel Stenger, and Amy Roma – three lawyers (see this issue's cover story) who chart a course for America to reclaim its lost primacy in the realm of nuclear technology.

Bruce W. Ruffalo

Editor

***Click here* for some not-so-hot stock tips for utility employees.**

(From the Editor's blog, at www.outsmartingthegrid.com.)

SMALL & MODULAR REACTORS

Putting America at the Nuclear Forefront (Again!)

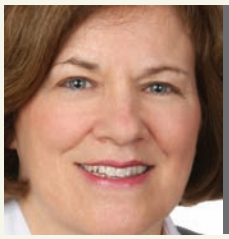
By Mary Anne Sullivan, Daniel F. Stenger and Amy C. Roma

In a March 23, 2010 op-ed piece in the Wall Street Journal, U.S. Secretary of Energy Dr. Steven Chu extolled the benefits of investing in the U.S. nuclear energy industry. Investing in new nuclear reactors, Secretary Chu argued, not only provides clean energy, but also is vital to maintaining America's leadership in nuclear technology. "Our choice is clear," continued Secretary Chu, "[d]evelop these technologies today or import them tomorrow."

Of particular interest was the Secretary's promotion of small and modular reactors (SMRs) – nuclear reactors that fall generally in the range of 300 megawatts (MW) or less. If commercially successful, SMRs could provide a technological advantage for the U.S. and someday become a significant source of U.S. exports.

The Promise of New Technology

What makes SMRs so promising? In addition to lower upfront capital costs than their large-scale cousins, one of the most appealing aspects of SMRs is their flexibility. Many are modular and may start as single units, allowing customers to increase gener- »



SMRs based on light water reactor technology may well face a shorter licensing review.

Mary Anne Sullivan

ating capacity incrementally and keeping upfront costs and risk low. Many of the SMR designs are capable of factory production, allowing cost savings from manufacturing economies to be passed along to customers. SMRs can serve remote locations or small power grids, or can allow a facility such as a military base to operate off the grid altogether.

SMRs have the potential to become a major component of exports by the U.S. nuclear industry. There is significant interest in SMRs for both developing and developed countries. For developed countries, SMRs give utilities the ability to add carbon-free baseload capacity as needed. They also have industrial and other applications, such as desalinization plants and oil sands development. For developing countries, SMRs can be used to serve remote locations or where the power grid cannot support large, 1000+ MW reactors. Potential markets for U.S. SMRs identified by a recent U.S. Department of Commerce report include Jordan, Latvia, India, Turkey, the UAE, China and Morocco.

Getting Off the Ground

Recently, DOE's Savannah River National Laboratory has begun exploring the concept of an energy park at the Savannah River facility in South Carolina that could host multiple SMR demonstration units. While the energy park is still in the conceptual phase, the facility operator, Savannah River Nuclear Solutions, has taken preliminary steps towards implementation. In September, Savannah River and Hyperion Power Generation, Inc. entered into a memorandum of understanding to explore the potential development of a prototype of the Hyperion SMR at the facility. The Hyperion HPM reactor design (Hyperion Power Module) is an approximately 25 megawatts electric (MWe) reactor that uses uranium nitride fuel and a lead-bismuth eutectic as the coolant. The reactor is intended to be buried 33 feet underground and replaced every 8-10 years.

In October, Savannah River and GE Hitachi Nuclear Energy, Inc. announced that they too have entered into a memorandum of understanding to explore the potential of developing GE Hitachi's PRISM (Power Reactor Innovative Small Module) reactor at the proposed energy park. PRISM is a 299-MWe fast neutron reactor design that will use recycled spent fuel and liquid sodium as coolant. Both the Hyperion and GE Hitachi reactors are significantly different than the large-scale light water reactors currently used at most of the commercial nuclear power plants in the United States, suggesting that test facilities at a DOE site may be a good way to demonstrate their technologies.

Another recent development in the SMR arena includes Tennessee Valley Authority's November 10, 2010 announcement that it is evaluating the feasibility of building two Babcock & Wilcox-designed mPower reactors on the site of the abandoned Clinch River Breeder Reactor in Oak Ridge. The mPower reactor is a 125-MW light water reactor.

Challenges to Deployment

SMRs face potential challenges before they are ready for licensing and manufacture in the United States. One of the first hurdles that SMR designers will face is the licensing process at the U.S. Nuclear Regulatory Commission (NRC). The NRC, the agency responsible for regulating commercial nuclear activities in the United States, would be responsible for approving the »

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Public Utilities Reports, Inc.
8229 Boone Blvd., Suite 400
Vienna, VA 22182
Phone: 703–847–7720
800–368–5001
Fax: 703–847–0683
http://www.pur.com

Bruce W. Radford
Editor & Publisher
radford@pur.com

Alex H. Stefanescu
Designer
ahstephen@charter.net

E-mailed to all *Fortnightly* subscribers.

For e–mail address changes or other information, contact *jcole@pur.com* or 800–368–5001.

reactor designs, licensing the construction and operation of SMRs, licensing any manufacturing plants designed to produce the reactors for commercial use, and licensing the export of reactors to foreign countries. The NRC's design certification and other licensing regulations, however, are geared toward large-scale light water reactor designs. The agency's regulations and practices will need to be tailored to the needs of SMRs.

Despite the obstacles, the SMR industry keeps pushing ahead. Working with both the NRC and the U.S. Department of Energy (DOE), SMR designers have made significant progress in the past year and appear to be moving in a positive direction.

Licensing at NRC

In order to bring SMRs to the commercial market in the United States, the reactors will need to be licensed by the NRC. Because SMR designs are relatively new and differ significantly from each other and from existing large-scale light water reactor designs, the NRC does not yet have specific regulations or guidance in place for SMRs. That does not mean, however, that the agency is incapable of reviewing design certification or license applications for SMRs. Historically, when an applicant has proposed to use a technology that is significantly different from other technologies licensed by the agency -- as was the case with the Pebble Bed Modular Reactor, a 165 MWe modular reactor design that was in pre-application discussions with the NRC for several years before the sponsor halted the effort in the United States – the NRC worked with the applicant to identify the most appropriate licensing process to use and to determine on a case-specific basis which of the general design criteria and other safety and licensing standards in the regulations would apply to the new design.

Several SMR developers have already had preliminary discussions with the NRC about their designs and an appropriate licensing process. In addition to the Hyperion and GE Hitachi reactors, these include: NuScale Power, Inc. for its 45 MWe reactor, Babcock & Wilcox Company for its 125 MWe mPower reactor, Toshiba Corporation for its 10 MWe 4S reactor, and Westinghouse Electric Company for its 335 MWe IRIS reactor. Still other SMR developers appear to be waiting in the wings to commence discussions with the NRC.

The preferred licensing approach for SMR designers appears to be to seek design certification under 10 C.F.R. Part 52, under which the NRC approves the reactor design through a rulemaking process. Because the design certification process is independent of any particular location, it avoids potentially contentious siting and environmental issues.

An SMR developer can also submit an application to license a prototype reactor. A prototype would allow the SMR designer to accumulate test data to help demonstrate the adequacy of new design features.

Still other options include seeking a license from the NRC to construct and operate a commercial SMR at a specific site or seeking an NRC permit that pre-approves a selected site. The NRC has streamlined its licensing process to allow for a combined operating license (COL) issued under Part 52 authorizing construction and operation of the facility. With the COL approach, most design issues will be resolved before the license is issued and construction begins. This approach avoids the costly design-as-you-go problems that plagued nuclear power plant projects in the 1970s and 1980s. The early site permit (ESP) process enables the NRC to approve a site for a nuclear reactor independent of an application to construct the facility. Conceptually it should be possible for an ESP to encompass a site selected for one or more SMRs or a combination of large-scale reactors and one or more SMRs.

Finally, an SMR vendor may apply for a manufacturing license under Part 52. A manufacturing license allows the licensee to fabricate essentially complete facilities.

No matter which licensing path a company decides to pursue, the regulations and associated guidance will need to be adjusted to accommodate the size, technology, and other unique needs of SMRs. Under the NRC's current licensing regime, a prospective applicant for an SMR design certification needs to analyze the NRC's general design criteria and other licensing standards, including the NRC's Standard Review Plan (NUREG-0800), »

Potential markets include Jordan, Latvia, India, Turkey, UAE, Morocco and China.

Daniel F. Stenger

to identify which standards seem applicable to its facility and which do not. This is a cumbersome process that adds costs and uncertainty for the SMR licensee.

If an SMR designer were interested in applying for a manufacturing license, it would be pursuing a course used only once before – in 1982, for the floating nuclear power plant design. The NRC has noted that its regulations for a manufacturing license are structured for an essentially complete facility, encompassing both the nuclear steam supply system (NSSS) and balance-of-plant. As a result, rulemaking may be necessary to allow issuance of a manufacturing license authorizing the manufacture and transport of only major portions of an SMR, such as the NSSS, and combining these with structures and systems built at specific sites

If Congress passes an energy bill, it seems likely the bill will support SMRs.

Amy C. Roma

either in the United States or abroad.

In short, the existing licensing paths may prove to be lengthy and uncertain – a challenge for any new technology seeking a share of the power generation market.

Streamlining the Process

To reduce the uncertainty, the NRC is taking steps to better align the licensing process to the needs of SMRs. The Commission's initiatives include:

- **A Focus on Safety**. Promoting the use of a risk-informed licensing framework for SMRs so as to focus NRC review on the systems and design features that contribute most to safety. In a policy directive, the NRC Commissioners directed the Staff to use risk-informed techniques to "enhance the efficiency of the review process."
- **Anticipating Technical Issues**. Examining the NRC's existing regulations and policies to identify technical and licensing issues unique to SMRs. The NRC has already identified a number of issues – ranging from operator staffing, security requirements and emergency planning to decommissioning funding, nuclear insurance and other financial matters – where tailoring to meet the specific needs of SMRs seems warranted.

The Commission's objective is to accelerate the development of a licensing framework informed by risk insights and to do so in a manner that makes the reviews of SMR design certification and COL applications more safety focused and more efficient.

A streamlined licensing process clearly makes sense. SMRs do not present the same level or nature of nuclear safety and security issues that must be addressed for large-scale reactors. In addition to their small size, some SMRs are safer and more secure by virtue of their design including, for example, underground construction and fuel types similar to those used at research reactors that have operated safely for decades at universities around the country.

The NRC recognizes that it needs to take a holistic approach. Issues such as operator staffing, physical security, and emergency planning for SMRs are interrelated. It does not make sense to address each issue in isolation; resolution of one issue is dependent on the treatment of others.

The quickest way to navigate the NRC regulatory process may be to construct a prototype. The test and operational data collected from a prototype plant can be used to support applications for design certification, COLs, and/or manufacturing licenses. Actual test data for new systems and design features will enable the NRC to evaluate the technology more effectively and confidently. Test data from a prototype also enables an applicant to develop pre-service and in-service testing requirements that could help support the NRC's design reviews.

This holistic approach is especially important given the range of newer technologies contained in many SMR designs. In the long run, a prototype plant can establish that a particular SMR design is reliable, safe, proliferation resistant, and economical. A prototype plant can also demonstrate the commercial potential of the design for potential customers.

An alternative – computer-assisted simulation – has DOE's support, but the NRC may be more hesitant to rely on simulations without the added support of prototype or pilot-scale reactors.

DOE Assistance

In addition to the proposed energy »

park at its Savannah River site, DOE has developed a multiphase plan to assist with commercialization of SMRs. DOE wants to help fund the development of an NRC licensing process tailored for SMRs. Over the next ten years, DOE has requested funding to assist the first two SMRs through the NRC licensing process. Because the NRC's regulations are generally tailored toward light water reactors, DOE has determined that SMRs based on light water reactor technology, such as the NuScale and B&W designs, are more likely to be subject to a shorter licensing review at the NRC. DOE is therefore likely to limit the initial competition for funding for design certification efforts to SMRs that use light water reactor technology.

To accommodate the non-light water SMRs, DOE has also requested funding for research and development on more advanced designs. However, if private funding can be found, especially to support the construction of prototypes, it is not clear that the proponents of these advanced reactors will have the patience to proceed on DOE's timeline. Many SMR companies wish to pursue a more aggressive schedule than the one envisioned by DOE. Having committed substantial resources over many years, they are already approaching the NRC to discuss licensing schedules for their reactors.

DOE's loan guarantee program for innovative energy technologies could benefit SMRs. While the program has been less than successful to date for large-scale reactors, the smaller risks associated with SMRs may make the loan guarantee process more successful for SMR developers. And because of the relatively low costs per reactor for some of the very small designs, some SMR vendors may benefit from a loan guarantee for a manufacturing plant for reactor fabrication. In order for loan guarantees to work for SMR developers, however, they will need some of the same program improvements larger reactor vendors are seeking, including project-specific risk evaluations and greater transparency in risk assessment.

Exporting Designs & Technology

As noted above, SMRs represent a major export opportunity for the United States. Once an SMR company receives its design certification or manufacturing license from the NRC, it may seek to export the SMR to foreign markets. Alternatively, some SMR designers may seek to have their technology licensed by nuclear regulatory agencies outside the U.S. and market their reactors solely abroad. Exports of SMRs and related nuclear technology are subject to U.S. export controls.

Many companies with SMR designs are in preliminary discussions with foreign countries, which may include the potential for construction of manufacturing facilities or the sale of reac- »

Notable SMR Reactor Designs

- Hyperion HPM (Hyperion Power Module) — *www.hyperionpowergeneration.com/product.html*
- GE Hitachi PRISM (Power Reactor innovative Small Module) — *www.gepower.com/about/press/en/2010_press/102710b.htm*
- NuScale power, Inc. — *www.nuscalepower.com/ot-Scalable-Nuclear-Power-Technology.php*
- Babcock & Wilcox Co.(mPower) — *www.babcock.com/products/modular_nuclear/generation_mpower.html*
- Toshiba Corp. (4S) — *http://en.wikipedia.org/wiki/Toshiba_4S*
- Westinghouse Electric Co. — *www.westinghousenuclear.com/Our_Company/Research_&_Technology/research_areas.shtm, see http://en.wikipedia.org/wiki/International_Reactor_Innovative_and_Secure*

tors. Before actual exports of nuclear reactors or reactor components can begin, the U.S. must negotiate bilateral "Section 123 Agreements" to establish a legal framework for cooperation and commerce in civilian nuclear energy with the foreign country if one does not exist already. The United States currently has Section 123 Agreements with more than 20 countries, and the State Department is negotiating agreements with still others.

In addition to a Section 123 Agreement, export licenses or other authorizations may be required from the NRC, DOE or the Department of Commerce. In general, an NRC export license is required for the export of a nuclear reactor, reactor components and nuclear fuel or other nuclear materials, that is, items generally associated with the NSSS portion of a plant. DOE administers controls over the export of technology related to "special nuclear materials," which includes, for example, exports of any technology, software and assistance (including services and training) related to nuclear reactors. The Department of Commerce has jurisdiction over the export of "dual-use" commodities, software or technology, including certain items related to nuclear power facilities, that is, items usually associated with the balance of plant.

SMR vendors are subject to export control restrictions for the transfer of technical data associated with a U.S. SMR design to a foreign entity, including potential customers. Sharing publicly available information and marketing materials with a foreign entity does not run afoul of U.S. export controls, but the line between such information and controlled technical information is not always clear. Indeed, even sharing controlled information with foreign nationals working on projects in the United States requires DOE "export" authorization.

It may be appropriate to consider whether the export control regime, including the NRC's and DOE's export regulations, can be tailored to address the lower risk and tighter regulatory budgets SMRs present. A targeted reform of U.S. nuclear export controls could help facilitate exports of SMRs to countries with whom the United States has Section 123 Agreements in place.

The Outlook in Congress

To date, SMRs have enjoyed bipartisan support in Congress, and the House Committee on Science and Technology and the Senate Energy and Natural Resources Committee have approved similar legislation designed to promote the development and deployment of SMRs along the lines envisioned by DOE. If Congress passes an energy bill, it seems likely the bill will support SMRs. Even in the absence of new authorizing legislation, however, appropriations bills will almost certainly contain support for DOE's research and development program for SMRs.

SMRs can provide reliable, virtually carbon-free baseload generation at a manageable capital cost. But as with so many other low-carbon energy technologies, much still needs to happen to realize the promise. DOE's efforts, including the development of the proposed Savannah River energy park, can help promote SMR technologies. The NRC must also continue its efforts to tailor its licensing processes for SMRs so that it can license these technologies at a cost and in a timeframe that will allow the U.S. to realize both the domestic benefit and the global market opportunity. ■

Mary Anne Sullivan, a partner in Hogan Lovells' Energy practice in Washington, D.C., frequently works on matters involving DOE. She previously served as General Counsel of the DOE and as Deputy General Counsel for environment and nuclear programs. Ms. Sullivan can be reached at maryanne.sullivan@hoganlovells.com or Tel. (202) 637-3695.

Daniel F. Stenger, a partner in Hogan Lovells' Energy practice in Washington, D.C., advises nuclear power plant and fuel cycle licensees, reactor vendors, suppliers, and other clients on matters involving the NRC and DOE, and other relevant international laws. Mr. Stenger can be reached at daniel.stenger@hoganlovells.com or Tel. (202) 637-5691.

Amy C. Roma, a senior associate in Hogan Lovells' Energy practice in Washington, D.C., focuses her practice on nuclear regulatory matters. She previously served two years as a judicial clerk for the NRC's Atomic Safety and Licensing Board Panel. Ms. Roma can be reached at amy.roma@hoganlovells.com or Tel. (202) 637-6831.

Next Month's FORTNIGHTLY

The December issue of *Public Utilities Fortnightly* magazine turns its eye on biomass fuel options, with a look at the economics of re-powering coal-fired plants, plus the seemingly incongruous concept of "biocoal" – a green, mock-coal substitute fuel created from agricultural crop wastes.

And here is more of what you will find:

- **Smart Meters, Crabby Customers?**
  A look behind the public backlash that arose in Texas when utilities such as Oncor, CenterPoint, and AEP began deploying missions of advanced electric meters, on the assumption that ratepayers would readily embrace the new technology.
- **The Bullish Case for Uranium**
  Why prices for uranium fuel have climbed over the past several years, and may well continue rising into the future, despite recent additions to worldwide supply from the dismantlement of Russian nuclear weapons.
- **Accounting Standards Go Global**
  How to understand and interpret utility balance sheets and financial statements as companies in Canada and the United States make the transition from GAAP (Generally Accepted Accounting Principles) to IFRS (International Financial Reporting Standards).
- **Workforce Wars**
  "Boomers" give way to Generations "X" and "Y," with serious implications for utility HR departments.
- **Transmission Planning With Least Regrets**
  What the Federal Energy Regulatory Commission can learn from California, which has been trying much the same thing, as the FERC works out the kinks in its current rulemaking proposal to make transmission planning more holistic and "top-down," while at the same time allowing private developers to claim a larger share of the grid sconstruction business.